HARRIS

HARRIS CORPORATION

Government Communications
Systems Division

RFI Response

Global Aeronautical Network Requirements and Design Concepts

NNC05ZVI011L

For:

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Attention:

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1.0 Introduction

Harris Corporation Government Communications Systems Division (GCSD) is pleased to submit this response to the NASA Glenn Research Center Request for Information (RFI) # NNC05ZVI011L for Global Aeronautical Network Requirements and Design Concepts. Harris is an international provider of communications products and services, focusing on Assured Communications for our customers. This focus is most appropriate for the global network being studied by NASA.

Harris is a major provider of communications systems for the Federal Aviation Administration (FAA). Our involvement with the FAA ranges from producing weather systems to integrating large communications systems. From work performed on the Operational and Supportability Implementation System (OASIS) and Weather and Radar Processor (WARP) programs, Harris has provided the FAA with accurate and timely weather data for private and commercial pilots and other system users. Through the Voice Switching and Control System (VSCS) and FAA Telecommunications Infrastructure (FTI) programs, Harris is leading the effort to upgrade the FAA's communications infrastructure. Harris is also involved in helping the FAA transition to VHF Digital Link Mode 3 technology architecture as defined by the Next Generation Air/Ground Communications (NEXCOM) program. Being the prime contractor on these programs puts Harris in a unique position to structure, execute, provision and operate the current and future communications services for the FAA. Note that the FAA has terminated portions of the NEXCOM program due to current funding constraints and may reinstate these efforts if funding becomes available.

Harris is dedicated to mission success for the FAA and future users of the National Airspace System (NAS). Our demonstrated performance on FAA programs substantiates a commitment to the importance of relationships with the FAA, team members, subcontractors and other stakeholders. Harris' outstanding work on multiple programs led the FAA to award Harris the Air Traffic Control Association Industrial Award in 2003.

As the FAA prepares to expand the capacity of the NAS, Harris continues to be involved. Harris is working on the Traffic Flow Management Modernization (TFM-M) program, and future concepts such as the Surveillance Data Network (SDN) and System Wide Information Management (SWIM).

Harris has been an industry participant in NextNAS and ACAST technical meetings since their inception, presenting technical papers as well as submitting RFI responses. Harris also supports the Joint Planning and Development Office (JPDO) and its new vision expressed in the Next Generation Air Transportation System (NGATS). We believe that NASA's Aeronautics directorate will bring forward essential research programs in the support of NGATS. As a contributor of ideas and technologies to the general aviation community, Harris will do what it can to make the ideas of the aerospace community a reality.

This response is organized in three main sections, addressing all aspects of the NASA RFI:

- Section 2 – Relevant Experience: Presents brief descriptions of current efforts and programs that are directly applicable to consideration of the Global Aeronautical Network.
- Section 3 – Comments on Draft Requirements: Contains comments on the draft Requirements for the Global Airspace System.
- Section 4 – Comments on Design Concepts: Contains comments on the proposed Design Concepts for the system.

1.1 Harris Points of Contact

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2.0 HARRIS RELEVANT EXPERIENCE

Harris is active in several major Government initiatives to define a future network-centric National Airspace System (NAS), which will be the U.S. subnetwork of the Global Airspace System. A few of these efforts are described in the following subsections.

2.1 Global CNS System Phase II (GCNSS II)

Harris is a member of the Boeing GCNSS II team, which is collaborating with the FAA and NASA to define requirements, benefits and transition plans for network-centric NAS operations. The enabling system for these operations is called System Wide Information Management (SWIM). Harris is a member of the SWIM Forum and the Technology and Transition Working Groups. Harris has made several presentations providing information on the FAA Telecommunications Infrastructure (FTI) program, which will provide the terrestrial IP backbone network for SWIM. We are also providing transition plans for the WARP aviation weather application and the OASIS flight planning application. Harris will also present a demonstration of network-enabled sharing of WARP data, including publishing of metadata and subscription by an authorized consumer.

2.2 FAA Telecommunications Infrastructure (FTI)

Harris is the prime contractor for the FTI, which will provide the FAA with economical and secure telecommunications services to all NAS facilities. FTI will provide the terrestrial IP common data network for SWIM applications. Consistent with DOT guidance, FTI is capable of supporting IPv6 as FAA programs evolve to the IPv6 architecture in the 2006-2007 timeframe. FTI also supports Homeland Security Presidential Directive 12 (HSPD-12), requiring standardization of digital identity information based on X.509v3 digital certificates. FTI implements virtual private networks using commercial service providers and standards. Its security options include IPSec tunneling and strong authentication which are directly applicable to the Global Airspace System, as well as firewalls, intrusion detection sensors, and vulnerability management capabilities. FTI supports 7X24 incident response and forensic data analysis capabilities for the FAA’s wide area network infrastructure.

FTI has an approved Security Certification and Authorization Plan (SCAP) and is accredited for NAS operations. FTI was designed to support the Common Criteria for Information Technology Security Evaluations (ISO 15048), and exceeds the requirements for Evaluation Assurance Level 3. FTI supports three unique protection profiles for the Telecommunications, Network Management Operations, and Integrated Business Systems. As such, it is uniquely positioned to provide a common network security infrastructure for Global Airspace Management.

2.3 Weather and Radar Processor (WARP)

Harris is the prime contractor for the FAA WARP system, which consolidates a wide variety of Aviation Weather data from Government and private sources and distributes it to Air Route Traffic Control Centers (ARTCCs) for display at Air Traffic Controller and Weather positions. WARP products include NEXRAD weather radar mosaics, satellite products, gridded data and alphanumeric products. Harris has developed an interface to WARP called WINS that allows access by external systems and users upon enrollment and scheduling of product delivery. This software is being modified to support a demonstration of WARP data sharing in the SWIM test bed.

2.4 NEXCOM Rapid Preliminary Design Effort (RPDE)

Harris was one of two contractors (the other being ITT Industries) selected by the FAA in February 2003 to begin development and prototyping of a digital ground infrastructure for air/ground communications. The NEXCOM architecture supports simultaneous voice and data link for ATM over narrowband RF links, as required for the Global Airspace System. It is also interoperable with the FAA’s legacy VHF AM voice network. The architecture also provides significant enhancements to security. Due to multi-year budget cuts, the NEXCOM RPDE program was terminated by the FAA in March 2004.

3.0 COMMENTS ON DRAFT REQUIREMENTS

Harris' comments on the draft Global Airspace System requirements are listed below in the order given in the RFI. We have grouped related requirements where appropriate.

3.1 Value Added. *Must be value added; cannot add cost without a return on investment that meets or exceeds those costs.*

A successful business case is required for investment in today's environment, whether the investment is by private industry, Government or both. This is certainly a reasonable requirement to place on the Global Airspace System. The economic factors appear to be very similar to those currently being studied for SWIM. In general, a positive return on investment for information sharing networks of these types depends on these factors:

- Lower telecommunication costs of IP-based networks as compared with dedicated point-to-point links for data transfer
- Competition among information providers
- Economies of scale for information providers
- Lower development cost for new applications and maintenance changes due to standardization of interfaces

Care must also be taken to minimize the investment associated with Global Airspace System infrastructure. The network should be conceived as a limited overlay on existing national infrastructures, minimizing unique requirements, databases or technology development and maintenance.

3.2. Global Operations. *Must operate over Global Airspace System, not just National Airspace System; must be interoperable throughout the World (not just US friendly nations).*

Global interoperability is an obvious requirement for a world-wide network. This characteristic, similar to that of the World Wide Web, also implies the need to safeguard the Global Airspace System from threats similar to those faced by the Web. It probably also will limit the applications that will be made accessible internationally, at least initially. A core set of applications might be those that are already standardized by ICAO and recognized as essential for air safety and traffic management. Examples include Aviation Weather products, safety and weather advisories, search and rescue information, and international flight plans.

3.3. Link-Independence. *Must be capable of utilizing whatever links become available – link independent.*

Network independence of the Global Airspace System requires that its definition and requirements be limited to the uppermost layers of the Open Systems Interconnection (OSI) Reference Model. This characteristic is the same as that of SWIM, and enables the system to use any combination of physical networks to carry IP messages throughout the system. Upper-layer functions include encoding, compression, encryption and formatting (Layer 6-Presentation) and Application (Layer 7) services such as access management, establishment of sockets and information brokerage. Since the underlying network(s) establish end-to-end connectivity between and among users, the Global Airspace System must be compatible with all standard modes of application interaction, e.g., publish/subscribe, Remote Procedure Call (RPC), and client/server.

3.4. Low-Bandwidth Links. *Must be able to perform critical Air Traffic Management (ATM) functions over low-bandwidth links.*

Modern Air Traffic Management (which includes Air Traffic Control, per the ICAO definition) must include data link and voice functionality. These functionalities may be integrated on a single link or carried on separate links. The issue is compatibility between legacy low-bandwidth ATM links and the IP network which underlies the Global Airspace System. (IP message transport typically requires at least fractional T1 bandwidths to avoid excessive latency.) This problem can be addressed with gateways that act as IP proxies for the ATM links and also adapt to legacy bandwidths and interfaces.

3.5. Security Mechanisms. *Must use same basic security mechanisms for Air Mobile and Ground Infrastructure (surface, terminal, en router, oceanic and space); critical ATM messages must be authenticated; must be capable of encryption when deemed necessary; security mechanisms must be usable over entire Global network - must not violate International Traffic in Arms Regulations.*

Security must be a major consideration with respect to a Global network. Any critical NAS functions that interface with the Global network should be protected by appropriate countermeasures. A Global Airspace Infrastructure implies mutually suspicious cooperating nodes, with encryption and authentication capabilities that are negotiated in near-real time at association set-up/tear down. Standard countermeasures such as IPSec and strong authentication must adapt to the encryption capabilities of the countries involved (i.e., they must support key agility and a variety of encryption algorithms). Intrusion detection and prevention software can also be applied effectively (at each subscriber site and within the network) to identify activity patterns that could indicate an attack. To facilitate interoperability in the Global Airspace Management architecture, encryption algorithms options should be limited to those that are free of ITAR restriction (commercially available worldwide). This should be an acceptable limitation for international interoperability, and would allow the infrastructure to operate with whatever security architecture is used in each participating country. Examples include the “black core” infrastructure of the Global Grid, the defense in depth strategy of commercial systems, and the open network strategies in place in developing countries. (NOTE: Defense in Depth is becoming pervasive – DoD architectures are looking at encryption to the desktop and all connections being encrypted with VPN technology.)

3.6. Shared Network Infrastructure. *Must operate across networks owned and operated by various entities; must be able to share network infrastructure; must use same technology (i.e. core networking hardware and protocols) for aeronautics as will be used by other industries (e.g. automotive, medical, banking, etc…)*.

The underlying networks over which the Global Airspace System communicates managed information may be the property of Governments, service providers or consortia. The basic requirement on the networks is that they support IP message protocols (IPv6 is suggested as a design standard and is discussed in Section 4 below.) The information management functions operate at OSI levels above the core networking hardware and protocol and so do not limit the infrastructure unless it cannot meet Quality of Service requirements (which are yet to be determined). The infrastructure could also be unsuitable if it does not conform to international standards and protocols in network equipment, messaging and applications support. There is a strong incentive worldwide to upgrade nonconforming national systems because of international industrial demand for use in banking, commerce, and other Web-based applications.

3.7. Information Sharing. *Must enable sharing of information with proper security, authentication, and authorization; e.g., situational awareness, passenger lists, aircraft maintenance.*

The three examples given require increasing levels of privacy and security. For data that improves Situation Awareness for aircrews, such as weather and proximate traffic reports, the major concern should be the integrity and availability of the information provided. There should be no need for user authentication or authorization; some of this information may be broadcast cleartext. Proximate traffic information must be addressed, but again requires no user authentication or authorization. Passenger lists could be abused, so their transmission should require some degree of security and authentication. Aircraft maintenance data may be regarded as the private property of aircraft owners and operators, and so require protection from governments or competitors. Sharing of limited information such as common failure mechanisms in particular aircraft or instances of human error is beneficial to air safety, but is more reliable if the sharing is voluntary and protected from punishment. User authorization and authentication should be managed by individual States under international guidelines and agreements that are as uniform as possible. Standardization on a global scale of authentication and authorization mechanisms would hinder interoperability of the Global system; hence we advocate free availability of critical information to facilitate flight safety.

3.8. User Needs. *The same network must accommodate commercial, military and general aviation needs.*

This requirement emphasizes the need to base applications on standards that are internationally accepted and commercially supported. General aviation pilots require applications that promote safety and situation awareness, are free or low in cost, and do not require registration or maintenance of security keys. Military and Homeland Security users need means of communication with civil aviation, and controlled access to data such as radar and ADS-B. The degree of international access to military and security data is yet to be determined but will be limited by agreements and circumstances. The Global Aeronautical Network and its protocols must be interoperable tools for information exchange, not artificial barriers.

4.0 COMMENTS ON DESIGN CONCEPTS

Harris' comments on Global Aeronautical Network design concepts are listed below in the order given in the RFI. Related concepts are grouped for comment when appropriate.

4.1. IP Standardization. *Must be IPv6 based.*

This is an acceptable design goal for future applications in the Global Airspace System, because IPv6 has powerful security and other characteristics The NAS common data network provided by FTI will evolve to support of IPv6 together with FAA applications. To ensure interoperability with systems already fielded, some provision needs to be made in the global network for downward compatibility with IPv4.

4.2. Mixed Traffic. *Must be capable of a prioritized mixing of traffic over a single RF link (e.g. ATM, maintenance, onboard security, weather and entertainment.)*

Mixing of traffic should not be a general Global Airspace System requirement, especially for ATM which has traditionally used dedicated frequencies. Priority and security precedence must be required where mixed traffic is the only means of justifying the cost of an RF link, as may be the case for satellite links. Some of the security and performance issues in a mixed-traffic airborne data environment are described in a paper by M.S. Ali et al, entitled "Airplane Data Networks and Security Issues," which was given at the 23rd Digital Avionics Systems Conference, Salt Lake City, UT, October 24-28, 2004.

4.3. IPSec-Based Security. *Must utilize IPSec-based security with Security Associations (SAs) bound to permanent host identities (e.g. certificates) and not ephemeral host locators (e.g. IP addresses).*

This is a sound approach for OSI Level 3 connections on links that have sufficient bandwidth to support IPSec. The Global Aeronautical Network architecture must allow for other security implementations where bandwidth is not available for IPSec.

4.4. Mobile Networks. *Must be capable of accommodating mobile networks.*

This is certainly a proper requirement for an aeronautical network. The Aeronautical Telecommunications Network (ATN) should be integrated into the Global Aeronautical Network architecture, together with alternative means of implementing, or avoiding the need for, ATN's Interdomain Routing Protocol (IDRP).

4.5. Multicasting. *Must be capable of multicasting.*

Multicasting is essential to avoid overloading the network with serial point-to-point messages in applications that are essentially broadcast. Today's router technology (mostly supporting IPv4) provides effective support for multicasting.

4.6. Scalability. *Must be scalable to tens of thousands of aircraft.*

The global network certainly needs to be sized to accommodate all aircraft participants. However, it should also be recognized that most aircraft will not usually be subscribers to global information, but will be members of local or national networks that have access to the global network. For example, U.S. aircraft operating in domestic airspace will probably have all their data needs met by the NAS and private networks. Some of the data may also be available internationally via the Global Airspace System and may be supplied to the NAS via the global network. The domestic aircraft will benefit from the information available through the global network even though they will not need to access this network directly.

4.7. Flexibility/Extensibility. *Must be topologically flexible; must be extensible to meet future needs.*

The design of the Global Aeronautical Network must include strategies for incorporation of legacy and future technologies. Gateways (devices which adapt IP networks to other types of data networks) are effective for legacy network integration. Use of standard middleware (e.g., CORBA, Web services) is an approach to accommodate present and future technologies.